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Visitation Aspect of shorebirds (*Tringa* spp.) in the Nakdong Estuary, Busan

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Abstract: This study was conducted at Nakdong Estuary in Busan Metropolitan City. The study aimed to monitor *Tringa* spp. at Nakdong Estuary through the comparative analysis of the long-term findings between the early 1990s (May, 1989~April, 1993) and the mid-2000s (May, 2002~April, 2008). During the research period (May, 1989~April, 1993, May, 2002~April, 2008: 10 years in total), the total of 116,761 birds representing 9 genera, 27 species were observed. Of them, the total number of *Tringa* genus of family Scolopacidae was 1,461 individuals (1.25%) representing 7 species, including 150 individuals of *Tringa erythropus*, 24 individuals of *Tringa totanus*, 28 individuals of *Tringa stagnatilis*, 1,223 individuals of *Tringa nebularia*, 9 individuals of *Tringa guttifer*, 24 individuals of *Tringa ochropus*, and 3 individuals of *Tringa glareola.* The monthly comparison of the visitation of the genera *Tringa* between two periods, there was no significant difference between the individual numbers in the early 1990s and the mid-2000s ($P<0.39$). There were more individuals observed in the early 1990s (Mean=163.00) than those in the mid-2000s (Mean=134.83). The results of monthly number of individuals in each year between the early 1990s and the mid-2000s (from May to April in following year) indicated that there was statistically significant mean difference in May ($P<0.01$). On the other hand, no statistical significance was found in the other months. The means of the individual numbers observed in the mid-2000s appear in Table 3 and Fig 3. As Table 3 indicates, the mean of individual number of five sites was 26.97: 57.33 individuals in Daema-deung (DMD), 11.83 individuals in Jangja and Shinja-Do (JJ & SJD), 7.33 individuals in Saja and Doyo-deung (SJ & DYD), 8.00 individuals in Lower Ulsuk-Do (LUD), 50.33 individuals in Ulsuk-Do (USD). There was statistically significant mean difference among these five sites ($P<0.01$).

Keywords: *Tringa* spp., Greenshank, Spotted Redshank, Visitation aspect

Introduction

The Nakdong Estuary, located in the extreme southern region of Korean peninsula, is known as a habitat for a lot of migratory birds. The estuary is a critical stopover site for waders to stay temporarily when they move north for reproduction in spring and also migrate to wintering sites in autumn.

In the downstream region of Nakdonggang River, the total number of 27 species of family Scolopacidae were observed: *Calidris* Genus (9 species), *Arenaria* Genus (1 species), *Limicola* Genus (1 species), *Tringa* Genus (7 species), *Xenus* Genus (1 species), *Heteroscelus* Genus (1 species), *Actitis* Genus (1 species), *Limosa* Genus (2 species), *Numenius* Genus (3 species), *Gallinago* Genus (1 species), etc. (Checklist of the Birds of Korea, 2009). Of them, the genera *Tringa*, small to medium sized, includes *Tringa erythropus*, *Tringa totanus*, *Tringa stagnatilis*, *Tringa nebularia*, *Tringa guttifer*, *Tringa ochropus*, *Tringa glareola*, and so on.

As crucial wintering sites for migratory birds, Nakdong Estuary areas are designated as the wintering grounds of waterfowl and waders in the downstream of the Nakdong River by Cultural Heritage Administration (Natural Monuments 179, 1966. 7. 13: 247,933,884 m^2). Moreover, the estuary, situated in the center of East Asia, plays the most significant role as stopover wintering sites for migratory birds (Post, 1983; Hong, 1997). The Nakdong Estuary also has foreshores and wetlands, abundant fishery resources, and wintering sites for migratory birds, thereby considered to be a valuable site for nature conservation. In order to protect this area, 5 conservation areas including the wintering grounds of waterfowl and waders are also designated as natural monuments in Korea.

The previous researches on the genera *Tringa* have been carried out mostly in Europe. These researches were on *Tringa nebularia* (Hancock *et al*., 1997), *Tringa tetanus* (Ottvall *et al*., 2005; Burton *et al*., 2006; Cresswell *et al*.,

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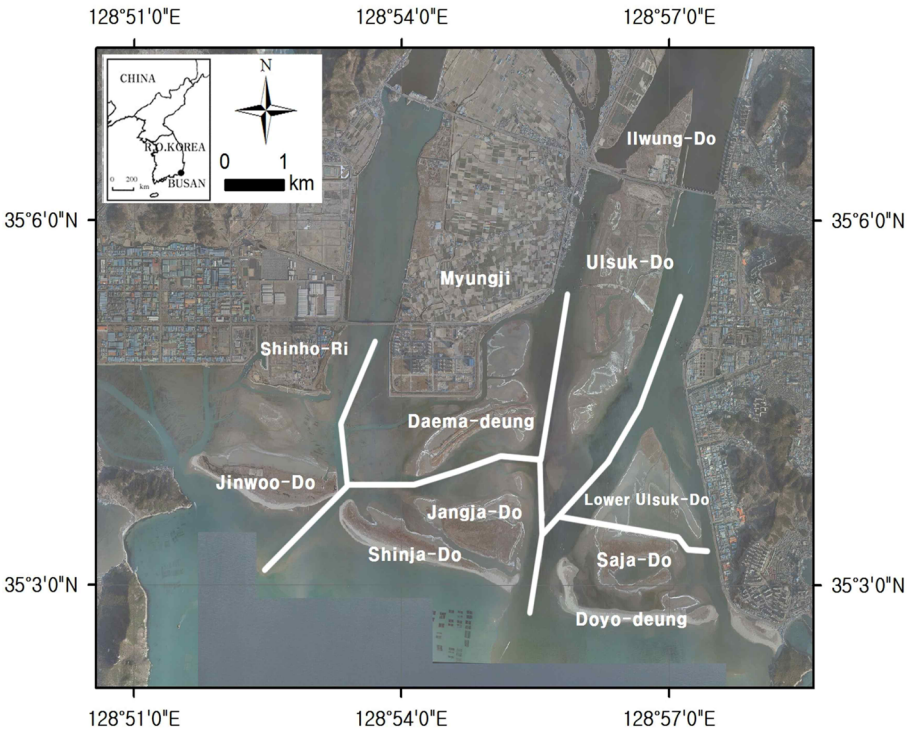

Fig. 1. Study area on Nakdonggang Estuary. The survey period between May 1989 and April 1993, and from May 2002 to April 2008.

2007; Gunnarsson *et al.*, 2010), and *Tringa ochropus* and *Tringa glarcola* (Nankinov, 1998; Vogrin, 1998). However, there have been only a few researches about Scolopacidae at the Nakdong Estuary: one is the study of waders (Hong, 2005), and another study is about the status of visitation of *Limosa* spp. and the role of Nakdong Estuary as a stopover site (Hong and Lee, 2012). Nevertheless, there has been no research about the genera *Tringa* so far.

As a result of the long-term monitoring of family Scolopacidae, which uses Nakdong Estuary for its stopover sites, it is significant to explore the status of migration and its habitat in order to maintain sound ecosystem of the site and to preserve the habitat for migratory birds.

Therefore, this study aimed to investigate the status of *Tringa* genera of family Scolopacidae and its preference for habitats at Nakdong Estuary through the comparative analysis of findings in the early 1990s and the mid-2000s.

Method

This study was surveyed at the whole areas in Nakdong Estuary once to three times a month in the early 1990s (May, 1989~April, 1993) and once to twice a month in the mid-2000s (May, 2002~April, 2008). In each month, the most frequently observed number of individuals was selected as the number of individuals of the month.

The research sites were five sites in total: ① Daema-deung (DMD), ② Jangja (JJ) and Shinja-Do (SJD), ③ Saja and Doyo-deung (SJ & DYD), ④ Lower Ulsuk-Do (LUD), ⑤ Ulsuk-Do (USD) (Fig. 1).

Two methods were used for surveys. One is the strip transect method to observe Scolopacidae with the naked eye and binocular (35×8, Nikon), moving along the designated route in a small craft. The other is the point census method to observe Scolopacidae through a telescope (×20~60, Sony) on a barge because of the geographical difficulty of access to the land or after landing to the Nakdong Delta (Fig. 1).

Tringa spp. was identified with the naked eye, a pair of binoculars, and a telescope and all numbers of individuals observed were recorded. In statistical analysis, Mann-Whitney U test was used for the monthly comparison of two groups and Kruskal-Wallis test was used for the comparison of the individual numbers of different sites.

Result

Overall findings

During the research period (10 years in total), the total of 116,761 individuals of family Scolopacidae representing 9 genera, 27 species were observed in the Nakdong Estuary: *Calidris* Genus 9 species, *Arenaria* Genus 1 species, *Limicola* Genus 1 species, *Tringa* Genus 7 species, *Xenus* Genus 1 species, *Heteroscelus* Genus 1 species, *Actitis* Genus 1 species, *Limosa* Genus 2 species, *Numenius* Genus 3 species, *Gallinago* Genus 1 species. Of them, the total number of *Tringa* genus of Scolopacidae was 1,461 individuals (1.25%) representing 7 species.

The status of individual numbers of the genera *Tringa*

During the research period (May, 1989~April, 1993, May, 2002~April, 2008: 10 years in total), the total of 116,761 birds representing 9 genera, 27 species were observed in the Nakdong Estuary. Of them all, the total number of *Tringa* genus of Scolopacidae was 1,461 individuals (1.25%) representing 7 species, including 150 individuals of *Tringa erythropus*, 24 individuals of *Tringa totanus*, 28 individuals of *Tringa stagnatilis*, 1,223 individuals of *Tringa nebularia*, 9 individuals of *Tringa guttifer*, 24 individuals of *Tringa ochropus*, and 3 individuals of *Tringa glarcola*.

As a result of the observed numbers of individuals of *Tringa* genus by year, 67 individuals representing 3 species were observed in the first year (May, 1989~April, 1990) of the early 1990s (May, 1989~April, 1993). 176 individuals representing 5 species were observed in the second year (May, 1990~April, 1991). 167 individuals representing 4 species were observed in the third year (May, 1991~April, 1992). 242 individuals representing 1 species were observed in the fourth year (May, 1992~April, 1993). Then, 82 individuals representing 1 species were observed in the fifth year (May, 2002~April, 2003) of the mid 2000s (May, 2002~April, 2008). 65 individuals representing 5 species were observed in the sixth year (May, 2003~April, 2004). 252 individuals representing 4 species were observed in the seventh year (May, 2004~April, 2005). 160 individuals representing 6 species were observed in the eighth year (May, 2005~April, 2006). 120 individuals representing 2 species were observed in the ninth year (May, 2006~April, 2007). Lastly, 130 individuals representing 4 species were observed in the tenth year (May, 2007~April, 2008).

The monthly comparison of the visitation of the genera *Tringa* between two periods

The analysis of the mean difference of observed numbers of *Tringa* genera *Tringa* spp. between the early 1990s and the mid-2000s was conducted to find out the fluctuations of the number of their individuals (Table 1). As the results shown in Table 1, there were no statistically significant mean differences of the numbers of individuals between the early 1990s and the mid-2000s (P<0.39). The number of individuals in the early 1990s (Mean=163.00) was larger than that in the mid-2000s (Mean=134.83).

As shown in Table 2, the results of monthly number of individuals in each year between the early 1990s and the mid-2000s (from May to April in following year) indicated that there was statistically significant mean difference in May (P<0.01). On the other hand, no statistical significance was found in the other months.

It was found from the means between the early 1990s and the mid-2000s that no or few individuals migrated from November to February, and in May and June. Then, in spring, relatively large number of individuals migrated in March and April. *Tringa* genera began to migrate in July, and then the largest number of individuals migrated in September. Lastly, the number of individuals decreased steadily in October. In the mid-2000s, most of *Tringa* genera migrated in April and May. They began to migrate in August for the fall season, and the largest number of individuals migrated in September. As the monthly means are indicated in Figure 2, the numbers of individuals observed in the early 1990s were approximately 1.2 times more than in the mid-2000s.

In comparison with the monthly number of individuals between the early 1990s and the mid-2000s, the migration began in March of the early 1990s, and then in April and from July to October. In the mid-2000s, relatively large numbers of individuals migrated in April, May, June, and from August to October.

In the light of the comparison of the visitation status between two periods, relatively large numbers of individuals

Table 1. Comparison of early 1990s to middle 2000s in the number of individuals of Shorebirds (*Tringa* spp.) in the Nakdonggang Estuary (89-93: 1989-1993, 02-08: 2002-2008)

Division	Year	Mean	SD[1)]	M-W's U[2)]	p
89-93	4	163.00	72.21		
02-08	6	134.83	66.74	8.000	0.394
Total		146.10	66.52		

1) SD=Standard Deviation, 2) M-W's U=Mann Whitney U test

Table 2. Montly Comparison of the number of Shorebirds (*Tringa* spp.) in the Nakdonggang Estuary (89-93: 1989-1993, 02-08: 2002-2008)

Month		N (Year)	Mean	SD[1)]	M-W's U[2)]	p
May.	89-93	4	1.25	1.50	0.000	**0.010***
	02-08	6	46.00	36.34		
Jun.	89-93	4	1.50	2.38	9.500	0.568
	02-08	6	5.67	7.66		
Jul.	89-93	4	6.75	9.00	8.000	0.294
	02-08	6	1.67	4.08		
Aug.	89-93	4	31.75	29.34	8.500	0.449
	02-08	6	16.67	12.97		
Sep.	89-93	4	74.75	48.26	4.000	0.088
	02-08	6	30.17	21.69		
Oct.	89-97	4	28.50	49.25	9.500	0.593
	02-08	6	17.00	16.82		
Nov.	89-93	4	0.25	0.50	5.500	0.138
	02-08	6	4.00	5.14		
Dec.	89-93	4	0.25	0.50	9.000	0.221
	02-08	6	0.00	0.00		
Jan.	89-93	4	0.25	0.50	9.000	0.221
	02-08	6	0.00	0.00		
Feb.	89-93	4	0.25	0.50	9.000	0.221
	02-08	6	0.00	0.00		
Mar.	89-93	4	8.25	15.20	6.000	0.068
	02-08	6	0.00	0.00		
Apr.	89-93	4	9.25	6.99	9.500	0.592
	02-08	6	13.67	13.74		

*P<0.01, 1) SD=Standard Deviation, 2) M-W's U=Mann Whitney U test

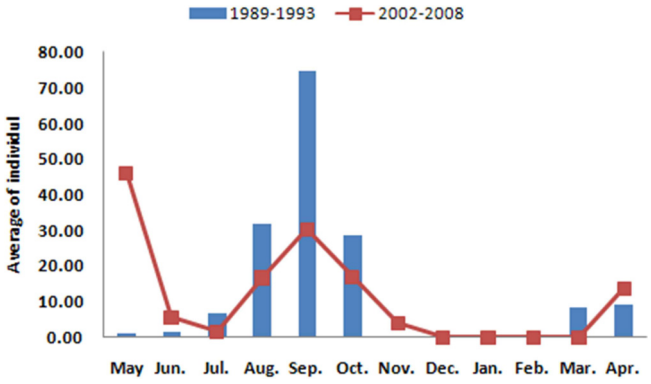

Fig. 2. Monthly change in the average number of individuals in Nakdonggang Estuary in 1989-1993 and 2002-2008.

were observed in March, April, and from July to October of the early 1990s. On the other hand, in the mid-2000s, relatively large numbers were observed from April to May and from August to October. Therefore, the beginning of the migration for the spring season in the mid-2000s tended to be delayed.

The Status of visitation of the genera *Tringa* by regions

The means of the individual numbers observed in the mid-2000s appear in Table 3 and Fig 3. As Table 3 indicates, the mean of individual number of five sites was 26.97: 57.33 individuals in Daema-deung (DMD), 11.83 individuals in Jangja and Shinja-Do (JJ & SJD), 7.33 individuals in Saja and Doyo-deung (SJ & DYD), 8.00 individuals in Lower Ulsuk-Do (LUD), 50.33 individuals in Ulsuk-Do (USD). There was statistically significant mean difference among these five sites ($P<0.01$).

With regard to the monthly total number of population in each site for six years, 150 individuals in May, 61 individuals in April, and 56 individuals in September were observed at Daema-deung (DMD). 82 individuals in May, 75 individuals in October, and 75 individuals in September were observed at Ulsuk-Do (USD). Lastly, 26 individuals in May and 23 individuals in September were observed at Jangja (JJ) and Shinja-Do (SJD) (Table 4).

The total population observed at five sites was 809. The

Table 3. The average of individuals of 5 region in the Nakdonggang Estuary from May 2002 to April 2008 (DMD: Daema-deung, JJ.SJD: Jangja.Sinja-do, SJ.DYD: Saja-do.Doyo-deung, LUD: Lower Ulsuk-do, USD: Ulsuk-do)

Site	Year	Mean	SD[1)]	χ^2	P
DMD	6	57.33	33.60	18.759	0.001*
JJ.SJD	6	11.83	5.49		
SJ.DYD	6	7.33	6.28		
LUD	6	8.00	8.07		
USD	6	50.33	30.78		
Total	30	26.97	29.78		

*P<0.01, 1) SD=Standard Deviation

Table 4. Monthly variation of the number of individuals at 5 regions in the Nakdong estuary between May 2002 and April 2008 (DMD: Daema-deung, JJ·SJD: Jangja·Shinja-do, SJ·DYD: Saja-do·Doyo-deung, LUD: Lower Ulsuk-do, USD: Ulsuk-do

Tringa spp.	DMD	JJ·SJD	SJ·DYD	LSD	USD	Total
May	150	26	1	17	82	276
Jun	7	3	6	0	18	34
Jul.	10	0	0	0	0	10
Aug.	44	5	20	4	27	100
Sep.	56	23	13	24	65	181
Oct.	16	8	0	3	75	102
Nov.	0	0	4	0	20	24
Dec.	0	0	0	0	0	0
Jan.	0	0	0	0	0	0
Feb.	0	0	0	0	0	0
Mar.	0	0	0	0	0	0
Apr.	61	6	0	0	15	82
Total	344	71	44	48	302	809

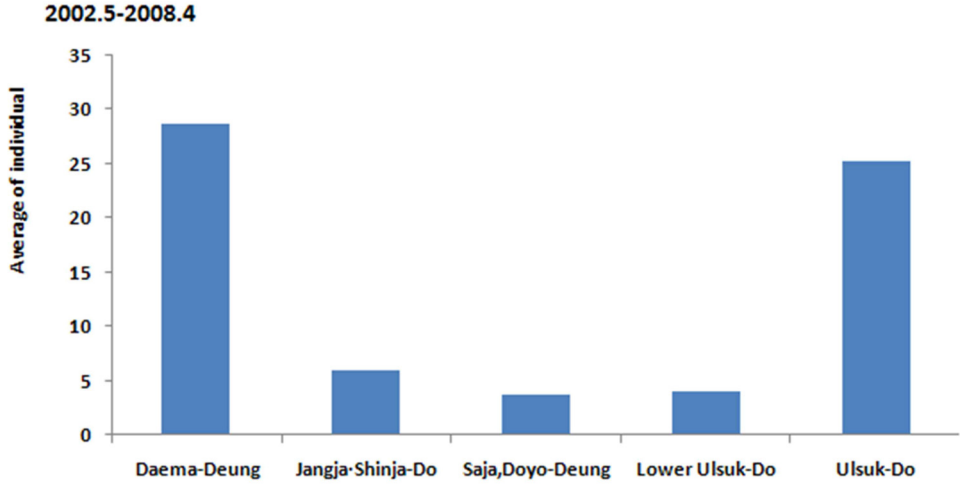

Fig. 3. The average number of individuals of 5 region in the Nakdonggang Estuary between May 2002 and April 2008.

site having the largest number of individuals observed was Daema-deung (DMD) (344 individuals). Of them, 150 individuals in May, 61 individuals in April, and 56 individuals in September were observed. The site having the second largest number of individuals was Ulsuk-Do (USD) (302 individuals). Of them, 82 individuals in May, 75 individuals in October, and 65 individuals in September were observed (Table 4, Fig. 3).

Discussion

Migratory birds need to complete nonstop flights of hundreds or thousands of kilometers, especially when they cross large bodies of water or inhospitable regions (Landys *et al*., 2000). Recently many waterbirds have decreased for 10 years, and their habits of wetlands have been destructed due to the reclamation and development of the areas (Koh 1999). The observed *Tringa* genera of Family Scolopacidae in the Nakdong Estuary were 1,461 individuals representing 7 species in total: Greenshank; *Tringa nebularia* (1,223), Spotted Redshank; *Tringa erythropus* (150), Marsh Sandpiper; *Tringa stagnatilis* (28), Redshank; *Tringa totanus* (24), Green Sandpiper; *Tringa ochropus* (24), Spotted Greenshank; *Tringa guttifer* (9), Wood Sandpiper; *Tringa glareola* (3).

Of the total of the genera *Tringa* (1,461 individuals, 7 species), 652 individuals representing 4 species were observed in the early 1990s: *Tringa nebularia* (547), *Tringa ochropus* (21), *Tringa totanus* (5), and *Tringa guttifer* (1). Additionally, 809 individuals representing 7 species were observed in the mid-2000s: *Tringa nebularia* (676), *Tringa erythropus* (72), *Tringa stagnatilis* (28), *Tringa totanus* (19), *Tringa guttifer* (8), T*ringa ochropus* (3), and *Tringa glareola* (3). The results indicate that there was a slightly more decrease of the number of the genera *Tringa* in the 2000s than in the 1990s. Meanwhile, 33 individuals (March), 37 individuals (April), 5 individuals (May), and 6 individuals (June) of the genera *Tringa* were observed in the early 1990s for the spring season. In the mid-2000s, however, no Tringa was observed in March. Then, 82 individuals (April), 276 individuals (May), and 34 individuals (June) were observed. The results indicate that the beginning of the migration for the spring season in the mid-2000s tended to be delayed, in comparison with that of in the early 1990s. It seems quite probable that the delay was caused by global warming and climate changes.

The representative habits of *Tringa* spp. in Korea are Nakdong Estuary and the wetlands along the west coast. On Yubu Island, one of the most important habits for waterbirds in West Coast of Korea, Lee *et. al*. (2002) observed 376 individuals of *Tringa nebularia* and 4 individuals of *Tringa erythropus* from 1999 to 2000. In fall, the total of 342 individuals of *Tringa nebularia* observed: August (82 individuals), September (180 individuals), and October (80 individuals). Like in Nakdong Estuary, *Tringa nebularia* migrated to the south by way of the wetlands along the west coast when it migrated to the wintering sites (Lee *et al*., 2002).

As for the status of individual numbers of the genera *Tringa* by regions, among the total population (809 individuals) for 6 years, 344 individuals at Daema-deung (DMD), 71 individuals at Jangja (JJ) and Shinja-Do (SJD), 44 individuals at Saja and Doyo-deung (SJ & DYD), 48 individuals at Lower Ulsuk-Do (LUD), and 302 individuals at Ulsuk-Do (USD). In terms of the monthly numbers of individuals by regions, 344 individuals in total were observed at Daema-deung (DMD): 61 individuals (April), 7 individuals (June), 10 individuals (July), 44 individuals (August), 56 individuals (September), and 16 individuals (October). In addition, 302 individuals in total were observed at Ulsuk-Do (USD): 15 individuals (April), 82 individuals (May), 18 individuals (June), 27 individuals (August), 65 individuals (September), 75 individuals (October), and 20 individuals (November)

When the genera *Tringa* moved south to the wintering sites in fall, rather than in spring, large number of individuals migrated. While migrating to the south, they tended to use Daema-deung (DMD) (171,061 m^2; except for waterway areas) and Ulsuk-Do (USD) (2,713,462 m^2) for their habits.

According to Busan Metropolitan City (2006), Myungji residential areas, located in the north of Daema-deung (DMD), and the west of Daema-deung (DMD) have diverse number of changes in terms of advent species of macrozoobenthos. In the case of the genera *Tringa*, it tends to prefer the freshwater areas (Cramp and Simmons, 1983). Therefore, the genera *Tringa* use both Daema-deung (DMD) which has brackish water zones and Ulsuk-Do (USD) which has freshwater areas.

As Hong and Lee (2012d) reported the similar results on the genera *Limosa*, the present study also showed that more number of the genera *Tringa* were observed when they migrated south for wintering sites in August (227 individuals), September (480 individuals), and October (216 individuals), rather than when they moved north for reproduction: in March (33 individuals), April (119 individuals), and May (281 individuals). Hence, the Nakdong Estuary is considered to be a critical site when shorebirds move to the south.

Since the genera *Tringa*, in particular, prefer freshwater areas, the factors leading to the decreases of habitats, such as water contamination and land reclamation caused by the developments of Ulsuk-Do (USD) in Nakdong Estuary, Myungji residential areas, and brackish water zones near Daema-deung (DMD), should be addressed. Furthermore, the systematic managements, such as the reduction of

artificial structures, the requirement of minimized human interference, and the restoration and security of feeding places, are required for conserving the ecosystem of these areas.

References

Burton, N.H.K., M.M. Rehfisch., N.A. Clark and S.G. Dodd. (2006). Impacts of sudden winter habitat loss on the body condition and survival of redshank *Tringa totanus*. Journal of Applied Ecology 43: 464-473.

Busan Metropolitan City. (2006) Mornitering of ecosystem in the Nakdong estuary. 310pp.

Cramp, S and K.E.L. Simmons. (1983) The Birds of the Western Paleartic. Vol. III: Oxford University Press. Oxford.

Cresswell. W., J. Lind., J.L. Quinn., J. Minderman and D.P. Whitfield. (2007). Ringing or colour-banding does not increase predation mortality in redshank *Tringa totanus*. J. Avian Biol. 38: 309-316.

Gunnarsson, G., Ottvall and H.G. Smith. (2010). Body mass changes in a biparental incubator: the Redshank *Tringa totanus*. J. Ornithol 151: 179-184.

Hancock, M.H., D.W. Gibbons and P.S. Thompson. (1997). The status of breeding Greenshank Tringa nebularia in the United Kingdom in 1995. Bird Study 44:290-302.

Hong, S.B. (1997) Fauna of water birds and breeding behavior of Little Tern and Kentish Plover in the Nakdong Estuary, R. O. Korea. D. Thesis, Hokkaido Univ. Hokkaido. 73pp.

Hong, S.B. (2005) A Research for Shorebirds on the Southermost of Nakdong Estuary. Kor. J. Eco. 28(4): 199-206.

Hong, S.B and I.S. Lee. (2012). Visitation Aspect and Roles of Nakdong River Estuary as Resting Ground for *Limosa* spp. Journal of Korean Nature 5(2): 193-198.

Koh, C. (1999). The Korean tidal flat, a brief introduction to geomorphology, reclamation and conservation, National NGO wetlands report: Ramsar 1999. Korean Wetlands Alliance.

Landys, M.M., T. Piersma., G.H. Visser., J. Jukema and A. Wijker. (2000) Water balance during real and simulated long-distance migratory flight in the Bar-tailed Godwit. Condor 102: 645-652.

Lee, H.S., J.Y. Yi., H.C. Kim., S.W. Lee and W.K. Paek. (2002) Yubu Island, the Important Waterbird Habitat on the West Coast of Korea and Its Conservation. Ocean and Polar Research Vol. 24(1): 115-121.

Nankinov, D.N. (1998). Wood Sandpiper *Tringa glareola* and Green Sandpiper *Tringa ochropus* in Bulgaria. International Wader Studies 10: 370-374.

Ottvall, R., J. Hüglund., S. Bensch & K. Larsson. (2005). Population differentiation in the redshank (*Tringa totanus*) as revealed by mitochondrial DNA and amplified fragment length polymorphism markers. Conservation Genetic 6: 321-331.

Post, J.C. (1983) Nakdong estuary barrage and land reclamation - Ecological aspects. Wat. Sci. Tech. 16: 223-231.

The Ornithological Society of Korea. (2009) Checklist of the Birds of Korea. 133pp.

Vogrin, M. (1998). Occurrence and passage of Wood Sandpiper *Tringa glareola* and Green Sandpiper *Tringa chloropus* on the Dravsko polje, north-eastern Slovenia. Wader Study Group Bull. 87: 55-58.

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